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WVR5200
Waveform Rasterizer
Specifications and Performance Verification

Technical Reference

REV A
This document applies to firmware version 1.2

Warning
The servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to all safety summaries prior to performing service.

www.tektronix.com

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- Worldwide, visit www.tektronix.com to find contacts in your area.

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Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. Parts, modules and replacement products used by Tektronix for warranty work may be new or reconditioned to like new performance. All replaced parts, modules and products become the property of Tektronix.

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General safety summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

To avoid fire or personal injury

Use proper power cord. Use only the power cord specified for this product and certified for the country of use.

Ground the product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Observe all terminal ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Power disconnect. The power cord disconnects the product from the power source. Do not block the power cord; it must remain accessible to the user at all times.

Do not operate without covers. Do not operate this product with covers or panels removed.

Do not operate with suspected failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Replace batteries properly. Replace batteries only with the specified type and rating.

Recharge batteries properly. Recharge batteries for the recommended charge cycle only.

Use proper AC adapter. Use only the AC adapter specified for this product.

Use proper fuse. Use only the fuse type and rating specified for this product.

Do not operate in wet/damp conditions.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry.

Provide proper ventilation. Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

Terms in this manual

These terms may appear in this manual:

WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*

CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Symbols and terms on the product

These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.

The following symbol(s) may appear on the product:

CAUTION
Refer to Manual

Protective Ground
(Earth) Terminal

Environmental Considerations

This section provides information about the environmental impact of the product.

Product End-of-Life Handling

Observe the following guidelines when recycling an instrument or component:

Equipment Recycling. Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. In order to avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.

This symbol indicates that this product complies with the European Union's requirements according to Directive 2002/96/EC on waste electrical and electronic equipment (WEEE). For information about recycling options, check the Support/Service section of the Tektronix Web site (www.tektronix.com).

Perchlorate materials. This product contains one or more type CR lithium batteries. According to the state of California, CR lithium batteries are classified as perchlorate materials and require special handling. See www.dtsc.ca.gov/hazardouswaste/perchlorate for additional information.

Restriction of Hazardous Substances

This product has been classified as Monitoring and Control equipment, and is outside the scope of the 2002/95/EC RoHS Directive. This product is known to contain lead, cadmium, mercury, and hexavalent chromium.

Preface

This reference document provides technical information about using the WFM5200 Series Waveform Rasterizer.

Related User Documents

The following related user documents are available:

- *WFM5200 Waveform Monitor Safety and Installation Instructions* (Tektronix part number 071-2887-XX). This multi-lingual document provides safety and compliance information along with hardware installation instructions to present the associated safety warnings.
- *WFM5200 Monitor User Manual* (Tektronix part number: 077-0531-XX). This document provides detailed operating information for the instrument.
- *WVR5200 Waveform Rasterizer Declassification and Security Instructions* (Tektronix part number 077-0544-XX). This document provides instructions clear or sanitize the memory devices and disable the data output devices.
- *WVR5200 Waveform Rasterizer Release Notes* (Tektronix part number 077-0546-XX).
- *WVR5200 Waveform Rasterizer Service Manual* (Tektronix part number 077-0550-XX). This document provides servicing information for the instrument and is intended for qualified service personnel only.
- *WFMRACK-NN and WFMRACK-ON Rack Adapter Kit Instructions* (Tektronix part number 071-1107-XX).
- *WVR5200 Waveform Rasterizer System Integration Instructions* (Tektronix part number 077-0548-XX). This document provides information about installing the instrument into a system.
- *WFM and WVR Series Management Information Database (MIB) Programmer Manual* (Tektronix part number 077-0261-XX). This document provides SNMP command reference for remotely controlling the instrument.

Related Reference Documents

The following related reference documents are available at the Tektronix, Inc. Web site (www.tektronix.com):

- *Preventing Illegal Colors*. This application note describes how the Diamond, Arrowhead, and Lightning displays can be used to help prevent the undesired impact of color gamut violations and to simplify the assessment of proper gamut compliance.
- *Understanding Colors and Gamut*. This poster provides a large visual display of how the Diamond, Arrowhead, and Lightning displays can be used to help prevent the undesired impact of color gamut violations.
- *A Guide to Standard and High Definition Digital Video Measurements*. This book is a primer for understanding the basics for making standard and high-definition, digital-video measurements.
- *Analog and Digital Audio Monitoring.* This application note describes how to monitor analog and digital audio signals. Also discussed are specific differences in the methods used to monitor analog audio versus digital audio, and how to plan the transition from monitoring analog audio to monitoring digital audio.
- *Audio Monitoring.* This application note describes balanced and unbalanced audio signals, and explains the physical and electrical characteristics and the specific strength and weaknesses of the different digital audio signal formats.
- *Monitoring Surround Sound Audio*. This application note describes the basics of 5.1-channel surround sound audio and how to use the Surround Sound display to visualize key audio-level and phase relationships in this audio format.

Specifications

The following tables list the specifications for the Tektronix WVR5200 Waveform Rasterizer. Items listed in the Performance Requirement column are generally quantitative and can be tested by the *Performance Verification* procedure in Section 2 of this manual. Items listed in the Reference Information column are useful operating parameters that have typical values; information in this column is not guaranteed.

The specifications listed in the Electrical Specifications portion of these tables apply over an ambient temperature range of +0 °C to +40 °C. The rated accuracies are valid when the instrument is calibrated in an ambient temperature range of +20 °C to +30 °C.

Electrical Specifications

Table 1: SDI input waveform vertical characteristics

Characteristic		Performance requirement	Reference information
Vertical Measurement Accuracy			Using graticule or cursor. Measure in YPbPr mode.
	1X	± 0.5% of 700 mV full scale mode	
	5X	± 0.2% of 700 mV full scale mode	
Gain		X1, X2, X5, and X10	
Variable Gain Range, Typical			0.25X to 2X, typical (variable gain multiplied by fixed gain to get total gain).
Frequency Response - HD	Luminance Channel (Y)	50 kHz to 30 MHz, ± 0.5%	50 kHz to 60 MHz for 1080P 60/59.94/50 formats (148.5 MHz interface sampling frequency).
	Chrominance Channels (Pb, Pr)	50 kHz to 15 MHz, ± 0.5%	50 kHz to 30 MHz for 1080P 60/59.94/50 formats (148.5 MHz interface sampling frequency).
Frequency Response - SD	Luminance Channel (Y)	50 kHz to 5.75 MHz, ± 0.5%	
	Chrominance Channels (Pb, Pr)	50 kHz to 2.75 MHz, ± 0.5%	
YPbPr to RGB Conversion Accuracy			0.1%, nominal

Table 1: SDI input waveform vertical characteristics (cont.)

Characteristic		Performance requirement	Reference information
Step Response, Typical			Sine-squared bars
	Preshoot		
	SD		≤ 0.3% peak (2T5 bar)
	HD		≤ 0.5% peak (2T30 bar) (2T60 bar for 148.5 MHz 1080p formats.)
	Overshoot		
	SD		≤ 0.3% peak (2T5 bar)
	HD		≤ 0.5% peak (2T30 bar) (2T60 bar for 148.5 MHz 1080p formats.)
	Ringing		
	SD		≤ 0.8% peak-peak (2T5 bar)
	HD		≤ 0.8% peak-peak (2T30 bar) (2T60 pulse for 148.5 MHz 1080p formats.) Most of the error seen on the display comes from the inherent ringing in the digital data. The response of the monitor is close to the theoretical limit of a perfect sinx/x reconstruction filter.
Pulse Response, Typical			Blackman pulse
	Baseline Ringing		
	SD		≤ 0.6% peak-peak (2T5)
	HD		≤ 0.7% peak-peak (2T30) (2T60 pulse for 148.5 MHz 1080p formats.) Pulse-to-bar ratio 0.995:1 to 1.005:1 on appropriate Sine Squared or Blackman 2T pulse. A sine-squared pulse near Nyquist is not band-limited and so inherently has ringing much larger than the rasterizer filter. A three term Blackman pulse with the same HAD has much less inherent ringing, so it is a better choice for most testing. See *Digital to Analog Conversion, Data and Filter Requirements*, SMPTE Journal Mar 1995, Vol. 104, Fibush, Baker, Penny.
Tilt	Field Rate	0.1%	
	Line Rate	0.1%	
Off Screen Recovery		0.1% variation in baseline of a 5 MHz modulated pulse when positioned anywhere on screen at any gain setting.	

Table 2: Waveform sweep (horizontal) deflection

Characteristic		Performance requirement	Reference information
Sweep	Accuracy	± 0.5%, all rates	Fully digital system
	Linearity	0.2% of time displayed on screen	Fully digital system
Timing Cursor Delta Readout Accuracy, Typical			± 0.5% of sweep time displayed on screen
Rates			1, 2, 3, or 4 line, or field depending on mode
Line Select			In 2-line sweep, the selected line is the first displayed line.

Table 3: Component vector mode

Characteristic		Performance requirement	Reference information
Vertical Bandwidth, Typical	SD		800 kHz
	HD		3.4 MHz (6.8 MHz for 1080P 148.5 MHz formats)
Vertical Gain Accuracy		± 0.5%	Fully digital system
Horizontal Gain Accuracy		± 0.5%	Fully digital system
Display to Graticule Registration		± 0.5%	Fully digital system limited by sample resolution
Vector Display			P_B is displayed on horizontal axis and P_R is displayed on vertical axis
Luma Qualified Vector Threshold Accuracy		± 1%	Vectors between the high luma and low luma threshold are displayed

Table 4: Waveform mode filter characteristics

Characteristic		Performance requirement	Reference information
Low Pass Filter Gain	SD, component only		1 ± 0.1% relative to flat gain
	HD, component only		1 ± 0.1% relative to flat gain
Low Pass Filter Frequency Response	SD, component only	≤ 3 dB attenuation at 800 kHz ≥ 32 dB attenuation at 3 MHz Filter meets IEEE STD-205	
	HD, component only	≤ 3 dB attenuation at 4.5 MHz ≥ 25 dB attenuation above 15 MHz, Noise bandwidth is approximately 8 MHz Stopband null at 18 MHz	For 1080P 148.5 MHz formats: ≤3 dB attenuation at 9 MHz ≥25 dB attenuation above 30 MHz

Table 5: SDI Lightning and Diamond modes

Characteristic		Performance requirement	Reference information
Vertical Gain Accuracy		± 0.5%	Fully digital system
Electronic Graticule Display	Diamond		RGB deflection axis indicated. Upper and lower halves are separated, to see negative signals
	Lightning		Displays signal components as follows: Y vertically Pb horizontally on top half of display P_r horizontally on bottom half of display
Detection Level	High Limit	+630 mV to +756 mV in 1 mV steps	
	Low Limit	-50 mV to +35 mV in 1 mV steps	
Detection Level Accuracy		± 3.5 mV	
Diamond Area Threshold Range			0% to 10%

Table 6: Data mode

Characteristic	Performance requirement	Reference information
Digital Waveform		Non-interpolated waveform display. Cursor identifies selected sample value (hex, decimal, binary). Cursor inserted on picture monitor output shows selected line
Digital List		Sequential list of sample values in table format. Cursor identifies selected sample
Display Format		HEX, DEC, BIN

Table 7: Arrowhead mode (NTSC/PAL composite limit display for SDI inputs)

Characteristic		Performance requirement	Reference information
Signal to Graticule Accuracy		± 1%, 100 IRE (700 mV), and 131 IRE (900 mV)	(PAL values in parenthesis)
Composite Limit Cursor Accuracy		± 1.0% at 100 IRE, 110 IRE, 120 IRE, and 131IRE (700 and 950 mV)	(PAL values in parenthesis)
		± 1.0% at -24 IRE, –33 IRE, and –40 IRE (-230 and 300 mV)	(PAL values in parenthesis)
Detection Level, nominal			Adjustable thresholds, 1% steps
Composite Limit Detection Level Accuracy		Detection Level = ± 7 mV of cursor level	Upper detection level can be set to 100, 110, 120, or 131 IRE (700 mV or 950 mV PAL)
			Lower detection level can be set to –24, –33, and –40 IRE (–230 mV or –300 mV PAL)
Composite Limit Area Threshold Range			0% to 10%
Luma Limit Detection Range, Typical	High		90 to 108%, 0.5% steps
	Low		+5 to –6%, 0.5% steps

Table 7: Arrowhead mode (NTSC/PAL composite limit display for SDI inputs) (cont.)

Characteristic	Performance requirement	Reference information
Luma Limit Detection Level Accuracy, Typical		Detection level = ± 7 mV of cursor level, nominal
Luma Limit Area Threshold Range		0% to 10%

Table 8: Spearhead HVS color space display

Characteristic	Performance requirement	Reference information
Signal to Graticule Accuracy	± 1%	

Table 9: Bowtie mode

Characteristic		Performance requirement	Reference information
Common Mode Rejection Ratio	SD	≥ 34 dB at 2.5 MHz	
	HD	≥ 34 dB at 5 MHz	
Interchannel Timing Match		± 0.5 ns	
Functional Description			Displays Y minus Pr and Y minus Pb signals. Requires bowtie signal to be useful. Null in center indicates the channels are time aligned.

Table 10: Timing display

Characteristic	Performance requirement	Reference information
Input Timing Relative to External Reference		Display of Vertical and Horizontal timing offset graphically and numerically. One clock cycle resolution. Patented proprietary display. Display Timing difference between input and Ref at rear panel or relative to an offset saved by the user.
Timing Display Zero Definition		For vertical timing, conforms to SMPTE RP168-2002. For horizontal timing, zero delay analog signals have coincident syncs. For digital signals, timing is such that if converted to analog by a WFM601A, then the resultant analog signal is conincident with the reference. Timing zero is equivalent to nominal zero delay on TG700. Also agrees with signal that shows minimal shift on the waveform display when going from internal to external. Vertical timing, according to SMPTE RP168, specifies that the lines with the start of the broad pulses are aligned.
Operation with input and reference being different formats		Compatible with any combination of frame abd field rates. (See Table 32.) (See Table 33.) (See Table 34.) In cases where there are multiple ways to interpret the phase relationship, multiple indicators of the phase will be shown. The numeric display will follow the smallest phase offset.
Link B to Link A		Display of dual link timing skew. Uncertainty of ± 1.5 clocks or 20 ns.
Input Timing Reference to Other Input		For Simultaneous inputs, allows selection of other channel as reference.

Table 11: Picture mode

Characteristic	Performance requirement	Reference information
Format (XGA)		Allows viewing picture in all formats. In SD formats, full screen picture occupies the central portion of the XGA raster area. For tile mode, the image is downsampled to fit the 512 x 350 size. In HD formats, picture is downsampled to fit in 1024 x 768 size (512 x 350 in 4-tile mode). In 1080P 60/59/50 dual link formats, picture is formed by averaging two lines, one from each link, then downsampling as required for display. In Low Frame Rate formats, frames are repeated as needed to achieve XGA frame rate; similar to 3:2 pulldown on some frame rates.
Pix Border On/Off		Allows user to mask or show the inactive portions of the raster such as ANC area for digital and sync for analog. When the border is on, the image is scaled to correct the aspect ratio. When the border is off, the image is either mapped pixel to pixel (full screen SD), or minimally decimated to reduce the artifacts.
Synchronization		Picture mode always uses internal timing; it is not affected by external sync.
Aspect Ratio		Allows choice of 16:9 or 4:3 for SD, to support widescreen.
Interlace to Progressive Options		Allows choices optimized for CRT, LCD, and interlaced displays.

Table 12: Data error detection (Video Session under STATUS button)

Characteristic		Performance requirement	Reference information
Data Integrity	270 Mb/s	Active picture and full field. Field rate resolution Complies with SMPTE RP165	Uses CRC check-word system. System is known as EDH (Error Detection and Handling) in industry literature. Error icon asserted for 1 second after any error.
	1.5 Gb/s, 3 Gb/s	Detects line CRC errors. Field rate resolution, separate reporting for errors in Y or Color Difference data streams	Error icon asserted for 1 second after any error.

Table 13: ANC data and ARIB

Characteristic	Performance requirement	Reference information
Displays		Detects ANC data in SDI streams, displays data from user specified DID and SDID. Displays Audio Control Packet. Decodes data for ARIB types B39, B37, B35, TR-B22, and TR-B23.
Alarms		Allows Alarms to be set for: ANC Parity, ANC Checksum, B39 Absence, B37 Absence, B35 Absence, TR-B22 Absence, TR-B23 Absence, and Absence of user specified DID and SDID.

Table 14: Audio bar displays

Characteristic		Performance requirement	Reference information
Modes			The user may configure the response dynamics (ballistics), reference levels, peak hold, offset, and scale of the meters to suit the monitoring needs of the particular installation or situation.
	Channel Mode		Any 16 channels configured into 8 pairs with phase correlation meters between pairs.
	Surround Mode		Left, Right, Center Lfe, Left surround, Right surround meters, and an extra channel pair. Phase correlation meters between L-R, L-C, C-R, Ls-Rs, L-Ls, R-Rs and the extra pair.
Audio Source			Monitoring digital audio embedded in serial digital video.
Level Meter Resolution			0.056 dB steps at 30 dB scale, from full scale to –20 dB FS. XGA Full Screen mode = 510 steps XGA 4-tile mode = 255 steps.

Table 14: Audio bar displays (cont.)

Characteristic	Performance requirement	Reference information
Correlation Meter Speed		User selectable 1 to 20. Factory default is set to 8. Speed 1 averages over 0.04 sec. Speed 2 averages over 0.04 sec. Speed 3 averages over 0.08 sec. Speed 4 averages over 0.12 sec. Speed 5 averages over 0.28 sec. Speed 6 averages over 0.52 sec. Speed 7 averages over 1.0 sec. Speed 8 averages over 1.5 sec. Speed 9 averages over 2.0 sec. Speed 10 averages over 2.5 sec. Speed 11 averages over 3.0 sec. Speed 12 averages over 3.5 sec. Speed 13 averages over 4.0 sec. Speed 14 averages over 4.5 sec. Speed 15 averages over 5.0 sec. Speed 16 averages over 5.5 sec. Speed 17 averages over 6.0 sec. Speed 18 averages over 6.5 sec. Speed 19 averages over 7.0 sec. Speed 20 averages over 7.5 sec. The Phase Correlation Meter Speed setting determines how quickly the meter reacts to changes in phase relationship. The meter reading is actually an average of correlation over time, and this setting determines how many samples are used to calculate the average. The instrument uses the fewest samples when this setting is 1, and the meter reacts almost instantaneously. The instrument uses the most samples when the setting is 20, and the meter reacts much more slowly. Experiment to find the setting that best fits your application.
Metering Ballistic Types		Selectable from true peak, PPM Type 1, and PPM Type 2
Peak Program Meter (PPM) Ballistic Response		PPM Type I (IEC Type I, essentially the same as DIN 45406 and Nordic N-9). PPM Type II (IEC Type II, the same as IEEE std. 152-1991). PPM Type I has a slightly faster attack time and a faster return time, 1.7 seconds to fall 20 dB as opposed to 2.8 seconds for Type II.
True Peak Ballistic Response		PPM Type II decay characteristics, no attack delay, factory default ballistic.

Table 14: Audio bar displays (cont.)

Characteristic		Performance requirement	Reference information
Peak Hold			True peak indicator remains at the most recent peak for a user selectable time of 1 to 10 seconds.
Clip Indication Delay Count			Consecutive FS samples for Clip Indication, user selectable Off or 1 to 100. Factory default is set to 1. A setting of 0 is equivalent to “Off”.
Mute Indication Delay Count			Consecutive “0” samples for Mute Indication, user selectable Off or 1 to 100. Factory default is set to 10. A setting of 0 is equivalent to “Off”.
Clip/Mute Error Readout Hold Time			1 to 30 seconds, user selectable. Factory Default set to 2.
Silence Indication Threshold			Audio level below which the signal will be considered “silent”. Used to trigger on-screen indication and alarms.
Silence Indication Delay			Off or 1 to 60 seconds, user selectable. Indication and alarm will not be asserted until signal stays below the silence threshold for this number of consecutive seconds. Factory default is set to 10. A setting of 0 is equivalent to “Off”.
Over Indication Threshold			Audio level above which the signal will be considered “over”. Used to trigger on-screen indication and alarms.
Over Indication Delay			Off or 1 to 30 seconds, user selectable. Indication and alarm will not be asserted until signal stays above the Over Indication Threshold for this number of consecutive seconds. Factory default is set to 2. A setting of 0 is equivalent to “Off”.
Adjustable Peak Program Level			Peak Program level is the level, relative to digital full scale, that the user chooses as the maximum desired level for monitored programs. The meter bars change to red above Peak Program level.
	Digital	Range 0 to –30 dBFS	
	Analog	Range 24 to –6 dBu	

Table 14: Audio bar displays (cont.)

Characteristic		Performance requirement	Reference information
Adjustable Test Level			Test level is the level, relative to digital full scale, that the user chooses as the test or "line up" level for monitored programs. The meter bars change to yellow between the Test and Peak Program levels.
	Digital	Range 0 to –30 dBFS	
	Analog	Range 24 to –6 dBu	
Set 0 dB Mark		Selections are 0 dBFS or 0 dBu, Peak Program Level (dB), or Test Level (dB)	Use this item to number the meter scale relative to Digital Full scale with digital sources, or relative to 0 dBu with analog sources, or to one of the two user-adjustable levels. When the zero mark is set to either Peak Program or Test level, the scale units are dBr, relative to the 0 dB level; units above the selected 0 dB mark are positive, while units below it are negative.

Table 15: Audio bar and Lissajous/Surround display

Characteristic	Performance requirement	Reference information
Description		In combination with Bar mode can have Lissajous or Surround Display in one tile. (See Table 14.)
Automatic Gain Control (AGC)	Lissajous gain control may be on or off	AGC time constant: 0.5 second to expand display after a 0 to –40 dB level transition, 0.05 second to reduce gain after a –40 to 0 dB level transition.
Manual Scaling		When AGC is off, level at perimeter of display follows Peak Program Level on Bar display.
Surround Display Frequency Weighting Filter		Frequency weighting can be A-weighting or Linear (Flat Response) as described in IEC 651. Dominant sound indicator can be turned on and off.

Table 16: Embedded audio extraction

Characteristic		Performance requirement	Reference information
Embedded Audio Formatting			24-bit Embedded audio is not supported (no AUX bits are extracted), only 20 most significant bits will be extracted. Supports SMPTE 272M Operation Level B only (48 kHz audio sampling rate synchronized with video).
	SD		Extract 20-bit audio formatted according to SMPTE 272M.
	HD		Extract 20 or 24 bit audio formatting according to SMPTE299M.
Channel Numbering			Channel numbers per SMPTE 272M (1 through 16) will be correctly shown on all displays.
Audio Rates			Supports 48 kHz audio sample rate.
Number of Channels Monitored for Presence			16 channels are monitored for presence. With Simultaneous inputs or dual link formats, 16 channels of each selected SDI input are monitored for presence.
Maximum Number of Channels Monitored for Activity			Can only monitor channels set up for display.
Audio levels			Bars display signals up to 0 dBFS. Must not exceed maximum power specification on analog outputs. Configure output attenuation if necessary.

Table 17: Headphones out

Characteristic	Performance requirement	Reference information
Meter Level to Headphone Output Gain		0 dB to –63 dB in 0.5 dB steps relative to maximum output level.
Digital Input to Headphone Output Gain Accuracy over Frequency	± 1.0 dB, 20 Hz to 20 kHz, 0 to –40 dBFS	
Digital Input to Headphone Output Distortion (THD + N), Typical		<0.05% at –10 dBFS, 20 Hz to 20 kHz, into 32 Ω. <0.2% at full scale into 32 Ω. <2% at full scale into 16 Ω.
Headphone Output Power Capability		Capable of continuously driving a 6.25 dBu sinewave into 32 Ω or 16 Ω.

Table 18: LCD display

Characteristic		Performance requirement	Reference information
Display Area	Horizontal		13 cm
	Vertical		10 cm

Table 18: LCD display (cont.)

Characteristic	Performance requirement	Reference information
Resolution		1024 (H) x 768 (V) pixels
Color Palette		6 bits per component. LSB is dithered to improve picture.
Pixel Defects	≤ 6 bad pixels	

Table 19: External display output (EXT DISPLAY)

Characteristic	Performance requirement	Reference information
Content		Identical to front-panel LCD display.
Display Format		1024 (H) x 768 (V) pixels at 60 Hz (XGA)
Digital Output Format		Single link T.M.D.S.
Connector		Female DVI-I
Analog Output Format		RGB
Analog Output Levels		0.7 V or 1 V for RGB signals, selectable. Fixed 5 V for H and V sync signals.
Hot Plug Detection		Not supported.
DDC Function		Not supported.
Color Palette		6 bits per component.

Table 20: LTC time code input

Characteristic	Performance requirement	Reference information
LTC Input Connector		Balanced, unterminated via rear-panel GCI remote connector. (See Table 27.)
LTC Input Impedance		Greater than 10 kΩ.
LTC Signal Characteristics		Linear Time Code per IEC Publication 461.
LTC Signal Amplitude Range, Typical		0.2 V_{p-p} to 5.0 V_{p-p}, balanced differential or single-ended.

Table 21: VITC decoding

Characteristic	Performance requirement	Reference information
Sources		SDI input 1A, 1B, 2A, or 2B.

Table 22: Serial digital video inputs

Characteristic		Performance requirement	Reference information
Format			1.5 Gb/s: compatible with SMPTE 292M/BTA-S004A. 270 Mb/s: compatible with 270 Mb/s SMPTE 259M. 3 Gb/s: compatible with SMPTE 424/M and SMPTE 425M.
Input Type			75 Ω BNC, internally terminated.
Cable Loss Accommodation		With 1/SQRT(f) characteristic at ½ of serial rate.	
	270 Mb/s	0 to 22 dB attenuation	Using Color Bars signal. Equivalent to approximately 319 m of Belden 1694A.
	1.5 Gb/s, 3 Gb/s	0 to 28 dB attenuation	Equivalent to approximately 170 m of Belden 1694A at 1.485 Gb/s, 115 m of Belden 1694A at 2.97 Gb/s.
Launch Amplitude Accommodation, Typical	For Full Specification		800 mV ± 10%
	Up to 20 dB Cable Loss		800 mV ± 30%
Jitter Tolerance, Typical	SD	0.35 UI_{p-p} above 50 kHz. Increases proportional to 1/f below 50 kHz	
	HD	0.35 UI_{p-p} above 1 MHz. Increases proportional to 1/f below 1 MHz	
Return Loss, Typical			> 15 dB to 1.5 GHz, > 10 dB to 3 GHz.
Isolation Between Inputs		> 45 dB to 1 GHz	
Time Base Range			>± 50 ppm

Table 23: Serial video output (SDI Out)

Characteristic		Performance requirement	Reference information
Format			3 Gb/s, 1.5 Gb/s, or 270 Mb/s same as selected input.
Content			Selectable as loop out of selected SDI input, or internally generated test signal.
Output Level		800 mV, ± 10% into 75 Ω load	
Rise and Fall Time, Typical	SD		400 ps minimum, 800 ps maximum, 20% to 80%.
	HD		135 ps maximum, 20% to 80%.
Return Loss, Typical			>15 dB to 1.5 GHz. >10 dB to 3.0 GHz.

Table 24: External reference

Characteristic	Performance requirement	Reference information
Input Type		Passive loop-through, 75 Ω compensated.
Operational		Locks to analog bi-level and tri-level signals of supported formats. (See Table 32.) (See Table 33.) (See Table 34.) Reference must have a frame rate compatible with input. WFM mode and Line Select derive timing from external sync. Picture mode and Data mode do not use timing from the external reference.
Analog Sync Format		Composite analog NTSC and PAL. Analog tri-level sync for supported 1080 and 720 line formats.
Input Signal Level, Typical		1 V ± 6 dB
Maximum Operating Input Voltage, Typical		± 5 V DC
Absolute Maximum Input Voltage, Typical		± 5 V DC
Return Loss, Typical		> 30 dB to 30 MHz
Hum Tolerance, Typical		Operates with 500 mV_{p-p} at 50 or 60 Hz.
Signal/Noise Tolerance, Typical		Operates to 25 dB.

Table 25: Ethernet

Characteristic	Performance requirement	Reference information
IP Address Mode		Supports manual and DHCP.
Rates	1000 Base-T, 100 Base-Tx, and 10 Base-T	
SNMP		For instrument control and feedback of status. Complies with SNMP version 2.
Connector Type		RJ-45 LAN connector supporting 10/100 Base-T.

Table 26: USB

Characteristic	Performance requirement	Reference information
Type		Host
Speed		Complies with USB 1.1 and USB 2.0 Full and Low-Speed specification. Full Speed operation in accordance with USB 2.0 spec is 12 Mb/s.

Table 27: Remote port

Characteristic	Performance requirement	Reference information	
GCI Connector		The GCI (ground closure interface) uses ground closures to control remote functions. The connector provides input/output for the following functions: LTC Time Code input ground closure alarm preset inputs	
Connector Type		Female HD-15	
Connector Pin Assignments		**Pin**	**Assignment**
		1	GND
		2 - 5	Reserved for future use
		6	GND
		7	Time code (+) input
		8	Time code (–) input
		9	Alarm ground closure output
		10	Preset A1 recall
		11	Preset A2 recall
		12	Preset A3 recall
		13	Preset A4 recall
		14	Preset A5 recall
		15	Preset A6 recall
Ground Closure Input Signalling		TTL thresholds, 5 V max input, –0.5 V min input; pull low to assert; internal 10 kΩ pull-up to 5 V on each input.	
Ground Closure Input Timing		Inputs must be asserted and stable for at least 150 ms to be reliably recognized.	
Ground Closure Output Characteristics		Open collector output; pulled up to 5 V by 10 kΩ in series with a diode; pull down current is limited by series 10 Ω resistor; max current is 100 mA.	
LTC Characteristics		(See Table 20.)	

Table 28: Power source

Characteristic	Performance requirement	Reference information
Electrical Rating		
Supply Connection		
Power Consumption, Typical		

Table 28: Power source (cont.)

Characteristic	Performance requirement	Reference information
Surge, Typical		
Fuse Rating		

Table 29: Miscellaneous

Characteristic	Performance requirement	Reference information
Real-time Clock Battery Life		>10 year

Physical Specifications

Table 30: Physical characteristics

Characteristic		Standard
Dimensions	Height	5.25 inches (133.4 millimeters)
	Width	8.5 inches (215.9 millimeters)
	Depth	
Weight	Net	
	Shipping	

Table 31: Environmental performance

Category		Standards or description
Temperature	Operating	0 °C to +40 °C
	Non Operating	–20 °C to +60 °C
Humidity	Operating	20% to 80% relative humidity (% RH) at up to +40 °C, non-condensing.
	Non Operating	5% to 90% RH (relative humidity) at up to +60 °C, non-condensing.
Altitude	Operating	Up to 9,842 feet (3,000 meters).
	Non Operating	Up to 40,000 feet (12,192 meters).

Table 31: Environmental performance (cont.)

Category		Standards or description
Cooling		The variable fans provide forced air circulation. Do not block ventilation openings.
	Bare instrument (no optional sleeves)	To ensure proper airflow, there must be at least 2 inches of clearance on both sides of the instrument, at least 2 inches of clearance from the rear of the instrument, and at least a 0.5 inch of clearance from the top of the instrument.
	Portable cabinet	Use only a Tektronix portable cabinet to ensure proper airflow with this instrument. When using the portable cabinet, the same minimum clearances as the bare instrument (see above) apply.
	Rack cabinet	Use only the Tektronix WFMRACK-NN or WFMRACK-ON rack adapter for this instrument. To ensure proper airflow when installing a rack adapter in a closed rack with solid walls, there must be at least 2 inches of clearance from both sides of the rack adapter frame to the rack side walls, at least 3 inches of clearance from the rear of the rack adapter frame to the rack's back wall, and at least 0.5 inch of clearance from the top of the rack adapter to another rack adapter or installed instrument. The rack intake air to the side vents must not exceed 40 °C.

Supported Input Formats and Allowed References

An X in the following three tables indicates that this combination is supported. Other combinations within each of these tables may work, but are unverified and only supported on a best effort basis.

Operation with an input from one of these three tables and a reference from another table is not supported (for example, a 1080i 50 input will not work with a 1080i 60 reference). Such mismatches may be reported on the display, and/or the display will "roll" due to the inherent incompatibility between the standards.

Table 32: 25 Hz and 50 Hz frame and field rates

	Reference format					
Input format	**PAL**	**720p 25**	**720p 50**	**1080p 25**	**1080sf 25**	**1080i 50**
720p 25 Hz	X		X			X
720p 50 Hz	X		X			X
1080p 25 Hz	X		X			X
1080sf 25 Hz	X		X			X
1080i 50 Hz	X		X			X
1080p 50 Hz	X		X			X
576i 50 Hz (625)	X		X			X
PAL 50 Hz	X					

Table 33: 59.94 Hz, 23.98 Hz, and 29.97 Hz frame and field rates

Input format	Reference format								
	NTSC	720p 23.98	720p 29.97	720p 59.94	1080p 23.98	1080sf 23.98	1080p 29.97	1080sf 29.97	1080i 59.94
720p 23.98 Hz	X			X	X	X			X
720p 29.97 Hz	X			X					X
720p 59.94 Hz	X			X	X	X			X
1080p 23.98 Hz	X			X	X	X			X
1080sf 23.98 Hz	X			X	X	X			X
1080p 29.97 Hz	X			X					X
1080sf 29.97 Hz	X			X					X
1035i 59.94 Hz	X			X					X
1080i 59.94 Hz	X			X					X
1080p 59.94 Hz	X			X					X
483i 59.94 Hz (525)	X			X					X
NTSC 59.94 Hz	X								

Table 34: 24 Hz, 30 Hz, and 60 Hz frame and field rates

Input format	Reference format							
	720p 24	720p 30	720p 60	1080p 24	1080sf 24	1080p 30	1080sf 30	1080i 60
720p 24			X	X	X			X
720p 30			X					X
720p 60			X	X	X			X
1080p 24			X	X	X			X
1080sf 24			X	X	X			X
1080p 30			X					X
1080sf 30			X					X
1035i 60 Hz			X	X	X			X
1080i 60 Hz			X	X	X			X
1080p 60 Hz			X					X

Option 3G is required for operation over SMPTE 424M/425M interfaces. Standard and Interface designators are SMPTE unless otherwise noted.

Table 35: Supported digital standards

				Frame (P, sF) or field (I) rates supported							
Standard	**Image format**	**Signal structure**	**Interface**	**60**	**59.94**	**50**	**30**	**29.97**	**25**	**24**	**23.98**
428-9 (D-Cinema)	2048 x 1080/P,PsF	4:4:4 XYZ / 12 bit 4:4:4 RGB / 12 bit	424M/425M				X	X	X	X	X
			372M					X	X	X	X
274M	1920 x 1080/P	4:2:2 YCbCr / 10 bit	424M/425M	X	X	X					
			372M	X	X	X					
	1920 x 1080/P,PsF	4:4:4 YCbCr / 10 bit 4:4:4:4 YCbCr+A / 10-bit 4:4:4 RGB / 10 bit 4:4:4:4 RGB+A / 10 bit	424M/425M				X	X	X	X	X
			372M				X	X	X	X	X
		4:4:4 YCbCr / 12 bit 4:4:4 RGB / 12 bit	424M/425M				X	X	X	X	X
			372M				X	X	X	X	X
		4:2:2 YCbCr / 12 bit 4:2:2:4 YCbCr+A / 12 bit	424M/425M				X	X	X	X	X
			372M				X	X	X	X	X
		4:2:2 YCbCr / 10 bit	292M				X	X	X	X	X

Table 35: Supported digital standards (cont.)

				Frame (P, sF) or field (I) rates supported							
Standard	**Image format**	**Signal structure**	**Interface**	**60**	**59.94**	**50**	**30**	**29.97**	**25**	**24**	**23.98**
274M	1920 x 1080/I	4:4:4 YCbCr / 10 bit 4:4:4:4 YCbCr+A / 10-bit 4:4:4 RGB / 10 bit 4:4:4:4 RGB+A / 10 bit	424M/425M	X	X	X					
			372M	X	X	X					
		4:4:4 YCbCr / 12 bit 4:4:4 RGB / 12 bit	424M/425M	X	X	X					
			372M	X	X	X					
		4:2:2 YCbCr / 12 bit 4:2:2:4 YCbCr+A / 12 bit	424M/425M	X	X	X					
			372M	X	X	X					
		4:2:2 YCbCr	292M	X	X	X					
260M	1920 x 1035/I	4:2:2 YCbCr	292M	X	X						
296M	1280 x 720/P	4:2:2 YCbCr	292M	X	X	X	X	X	X	X	X
ITU-R BT.601	720 x 576/I (625)	4:2:2 YCbCr	259M-C			X					
ITU-R BT.601	720 x 483/I (525)	4:2:2 YCbCr	259M-C		X						

Alarms

The following tables list the alarms that may be set for the waveform monitors.

Table 36: Common alarms

Alarm	Description
HW Fault	Indicates a system fault occurred. May require service.
SDI Input Missing	Indicates that no signal is detected on the selected SDI input.
SDI Input Signal Lock	Indicates unable to lock to selected SDI input signal.
Reference Missing	Indicates that no signal is detected on the Ref input when REF EXT is selected.
Ref Lock	Indicates unable to lock to the Ref input signal when REF EXT is selected.
Ref Fmt Mismatch	Indicates that the signal format detected on Ref input differs from the configured External Ref format.
RGB Gamut Error	Indicates that the selected video input signal contains colors that violate the configured Diamond gamut thresholds.
Composite Gamut Error	Indicates that the selected video input signal contains colors that violate the configured Arrowhead gamut thresholds.
Luma Gamut Error	Indicates that the selected video input signal contains luminance levels that violate the configured Luma gamut thresholds.
Video Fmt Change	Indicates that a change occurred in the format of the selected video input signal.
Video Fmt Mismatch	Indicates that the signal format detected on the selected video input differs from the configured Input Format or that the format detected differs from that indicated by the signal's SMPTE 352 payload identifier.
Vid/Ref Mismatch	Indicates that the Ref signal format is not compatible with the Input signal format. (See Table 32.) (See Table 33.) (See Table 34.)
Line Length Error	Indicates that the length of a video line differs from that expected for the detected video format.
Field Length Error	Indicates that the length of a video field differs from that expected for the detected video format.
EAV Place Error	Indicates that the location of the EAV timing reference signal differs from that expected for the detected video format.
SAV Place Error	Indicates that the location of the SAV timing reference signal differs from that expected for the detected video format.
Timecode Vitc Missing	Indicates that a break or discontinuity in the VITC has occurred.
Timecode Vitc Invalid	Indicates that the VITC was lost for one frame but has reappeared.
Timecode Ltc Missing	Indicates that a break or discontinuity in the LTC has occurred.
Timecode Ltc Invalid	Indicates that the LTC was lost for one frame but has reappeared.
Timecode Anc Missing	Indicates that a break or discontinuity in the ANC timecode has occurred.
Timecode Anc Invalid	Indicates that the ANC timecode was lost for one frame but has reappeared.
Closed Caption Missing	Indicates that the configured Closed Caption Transport stream or streams are not present in the selected video input signal.
CC Service(s) Missing	Indicates that one or more configured EIA 608 Required Services is not present in the closed caption data stream.

Table 36: Common alarms (cont.)

Alarm	Description
EIA608 Caption Error	Indicates a data error in an EIA608 data stream, excluding Extended Data Services and EIA708 Caption Data Packet errors.
V-Chip Presence Error	Indicates that no content advisory packet has been detected in the selected video input signal for at least 4 seconds.
V-Chip Format Error	Indicates that a content advisory packet contained illegal data or was formatted incorrectly.
Extended Data Services Error	Indicates a data error in Extended Data Services of an EIA608 data stream.
Caption Data Packet Error	Indicates a Caption Data Payload error in the EIA708 stream carrying EIA608 data.
Line 21 presence Error	Indicates no VBI caption signal was found on the configured Line and Timing of the selected video input signal.
ANC CC Presence Error	Indicates no caption ancillary data (SMPTE334M) was found in the selected video input signal.
TSID Missing	Indicates no Transmission Signal Identifier was found in the selected video input signal.
TSID Format Error	Indicates detected Transmission Signal Identifier is not an allowed value.

Table 37: HD specific alarms

Alarm	Description
Video Not HD	Indicates that the selected SDI video input signal is not an HD format.
Line Number Error	Indicates that the encoded line number differs from the counted line number.
Y Chan CRC Error	Indicates that the encoded CRC for a line's Y (luminance) samples differs from the calculated CRC.
C Chan CRC Error	Indicates that the encoded CRC for a line's C (chrominance) samples differs from the calculated CRC.
Y Anc Checksum Error	Indicates that the encoded checksum in a Y (luminance) ancillary data packet differs from the calculated checksum.
C Anc Checksum Error	Indicates that the encoded checksum in a C (chrominance) ancillary data packet differs from the calculated checksum.

Table 38: SD specific alarms

Alarm	Description
AP CRC Error	Indicates that encoded AP (active picture) CRC differs from the calculated CRC.
FF CRC Error	Indicates that encoded FF (full field) CRC differs from the calculated CRC.
EDH Error	Indicates that EDH (error detection and handling) has detected an error.

Table 39: Audio alarms (Options AUD)

Alarm	Description
Over	Indicates that the signal has exceeded the level specified by the Over Level setting for the period of time specified by the Duration for Over setting.
Silence	Indicates that the signal has fallen below the level specified by the Silence Level setting for the period of time specified by the Duration for Silence setting.
Clip	Indicates that the number of consecutive, full-scale digital audio samples monitored has exceeded the value specified by the Number of Samples for Clip setting.
Mute	Indicates that the number of consecutive “0” digital audio samples monitored has exceeded the Number of Samples for Mute setting.
CRC Error	Indicates that the AES channel status CRC as calculated by the instrument does not agree with the CRC embedded in the channel status bytes.
V Bit	Indicates that the Validity bit is set high for one or more AES audio samples. In the AES/EBU standard, a set validity bit indicates that the sample is not suitable for conversion to audio.
AES Parity	Indicates incorrect parity in one or more AES audio samples.
Emb. Audio Presence	Indicates that no embedded audio stream is detected in the selected SDI input.
(Embedded) Checksum	Indicates that the checksum present in the embedded audio stream does not match the calculated checksum.
(Embedded) Parity	Indicates incorrect parity in one or more embedded audio samples.
Emb. Group Sample Phase	Indicates embedded audio streams are not time-aligned due to asynchronous audio or data error.

Performance Verification

This section contains a collection of manual procedures for verifying that the following products perform as warranted:

- WFM5200 models and related options

This chapter is divided into two sections: *Incoming Inspection Procedures* and *Performance Verification Procedures*. The test procedures in this chapter provide for an extensive confirmation of performance and functionality.

NOTE. *Before performing any of the procedures and tests in this manual, the instrument must have been operating for a warm-up period of at least 20 minutes. (See Table 31 on page 17.)*

Test Records

Use the following tables to record the measured performance or Pass/Fail status for each step of the specified test procedure. In cases where a measurement is made in different units than specified in the manual, the actual measured values that correspond to the specification limits are shown in parentheses.

Test Record - Function Tests

Table 40: WVR5200 Waveform Rasterizer functional test record

Instrument Serial Number:	Certificate Number:		
Temperature:	RH %:		
Date of Calibration:	Technician:		
Functional test (incoming inspection)	**Incoming**	**Outgoing**	**Comments**
Basic Turn On and Self Test			
POST			
Front Panel Test			
LCD Pixel and Defects			
Diagnostics Tests			
Power Up Diagnostics			
Advanced Diagnostics			
Fan Test			
SDI Input Operation			
SDI 1A, 270 Mb/s			
SDI 1B, 270 Mb/s			
SDI 2A, 270 Mb/s			
SDI 2B, 270 Mb/s			
SDI 1A, 1.5 Gb/s			
SDI 1B, 1.5 Gb/s			
SDI 2A, 1.5 Gb/s			
SDI 2B, 1.5 Gb/s			
SDI 1A, 3 Gb/s (Option 3G)			
SDI 1B, 3 Gb/s (Option 3G)			
SDI 2A, 3 Gb/s (Option 3G)			
SDI 2B, 3 Gb/s (Option 3G)			
Waveform Stuck Bit Test			
External Reference			
NTSC Lock			
External Reference Waveform			

Table 40: WVR5200 Waveform Rasterizer functional test record (cont.)

Functional test (incoming inspection)	Incoming	Outgoing	Comments
Ref Missing			
Digital Audio Input (Option AUD)			
Embedded to Bar Display			
Embedded to Lissajous Display			
LTC Waveform and Decode			
LTC Waveform			
LTC Decode			
Ground Closure Remote			
Activate Preset			
Ground Closure Alarm			
Ethernet Functionality			
Dual Link Format Operation			

Video Performance Test Record

The following test record applies to all instruments.

Table 41: WVR5200 Waveform Rasterizer video performance test record

Instrument Serial Number:		Certificate Number:		
Temperature:		RH %:		
Date of Calibration:		Technician:		
Performance test	**Minimum**	**Incoming**	**Outgoing**	**Maximum**
SDI Input Equalization Range				
270 Mb/s Input Equalization Range				
Input 1A	22 dB			
Input 1B	22 dB			
Input 2A	22 dB			
Input 2B	22 dB			
1.5 Gb/s Input Equalization Range				
Input 1A	28 dB			
Input 1B	28 dB			
Input 2A	28 dB			
Input 2B	28 dB			
3 Gb/s Input Equalization Range				

Table 41: WVR5200 Waveform Rasterizer video performance test record (cont.)

Performance test	Minimum	Incoming	Outgoing	Maximum
Input 1A	28 dB			
Input 1B	28 dB			
Input 2A	28 dB			
Input 2B	28 dB			
SDI Serial Output Amplitude (test limits assume ±3.5% gain uncertainty in test oscilloscope)				
SDI Out 270 Mb/s	745 mV			849 mV
SDI Out 1.5 Gb/s	745 mV			849 mV
SDI Out 3 Gb/s (option 3G)	745 mV			849 mV

Test Record - Option AUD

Table 42: Audio option AUD test record

Instrument Serial Number:	Certificate Number:
Temperature:	RH %:
Date of Calibration:	Technician:

Performance test	Minimum	Incoming	Outgoing	Maximum
Headphone Level Accuracy Over Frequency				
Left (100 Hz)	–0.75 dBu			1.25 dBu
Right (100 Hz)	–0.75 dBu			1.25 dBu
Left (1 kHz)	–0.75 dBu			1.25 dBu
Right (1 kHz)	–0.75 dBu			1.25 dBu
Left (20 kHz)	–0.75 dBu			1.25 dBu
Right (20 kHz)	–0.75 dBu			1.25 dBu

Incoming Inspection

This section contains functional/operational checks appropriate to an incoming inspection.

The instrument must have been operating for a warm-up period of at least 20 minutes. (See Table 31 on page 17.)

Use the following procedures to check the basic functionality of the WVR5200 Waveform Rasterizer. The checks are arranged by model and option so that you can choose the sections that are appropriate for your instrument. The last two sections are for less critical waveform rasterizer features: the ground closure and Ethernet ports. You need only test these if you intend to use them. In general, you should test in the order presented, since later tests might depend on items checked in the earlier tests.

Required Equipment

The following equipment is required to perform the incoming inspection procedure.

Table 43: Required equipment – functional tests

Test equipment	Requirements	Example
Video test signal generator	1080p 59.94 3Gb/s HD signals (required for option 3G) ■ 100% color bars ■ 4 CH embedded audio (Group 1)	Tektronix TG700 with HD3G7 module
	1080i 59.94 1.5 Gb/s HD signals ■ 100% color bars ■ 10-bit shallow ramp matrix ■ 100% sweep 1-15 MHz ■ 4 CH embedded audio (Group 1)	Tektronix TG700 with HDVG7 modules
	525i 59.94 270 Mb/s SD signals ■ 100% color bars ■ SMPTE color bars ■ 8 CH embedded audio (Groups 1&2)	Tektronix TG700 with DVG7 module
	NTSC Composite Analog signals ■ 0% Flat Field or Black Burst	Tektronix TG700 with AVG7 module
	1080i 59.94 SMPTE 372M Dual Link signals ■ 100% color bars, format YCbCr+A 4:4:4 10-bit ■ 100% color bars, format GBR 4:4:4 10-bit	Tektronix TG700 with HDLG7 module
75 Ω coaxial cables (2 required)	RG-6 type coaxial cable with male BNC connectors, 1 to 2 meters long, suitable for use to 1500 MHz.	Belden 8281 or 1694A. Tektronix part numbers 012-0159-00 or 012-0159-01.
Precision 75 Ω terminator for Analog Video	75 Ω ±0.025% to 6 MHz, male BNC connector.	Tektronix part number 011-0102-03.
Waveform Monitor	SMPTE 259-C (270 Mb/s) and SMPTE 292M (1.5 Gb/s) inputs with EDH/CRC checking.	Tektronix WFM8300

Table 43: Required equipment – functional tests (cont.)

Test equipment	Requirements	Example
3 Gb/s Waveform Monitor (Option 3G)	SMPTE 424M /425M (3 Gb/s) input with CRC checking.	Tektronix WFM7120 or WFM8300 ***NOTE.*** *Only one waveform monitor is needed for the tests, so a 270M/1.5G/3G monitor will meet both of the above requirements.*
LTC (Timecode) generator	Complies with SMPTE 12M LTC specifications, capable of being locked to an NTSC composite analog video source.	Horita TG-50
HD-15 male connector with custom cable	Plugs into the REMOTE port, used to make the LTC and ground closure interface tests.	See "LTC Waveform" and "Ground Closure Remote" functional tests for cable construction details.
Voltmeter	0 V to 5 V range, 2% or better accuracy.	Fluke model 87
Computer and Ethernet Cable	Computer with web browser and Ethernet port; appropriate length Ethernet cable (8 conductor RJ-45 terminations, either straight through or crossover).	Used for Ethernet test.

Incoming Inspection Tests

Basic Turn On and Self Test

1. Connect the AC line cord to the rear of the instrument and to a 100 to 240 VAC source. Press the **Power** button to turn the instrument on.
2. After about 30 seconds, the power-on diagnostic page should appear on the screen.
3. Verify that all self tests pass. Any failures will be shown in red. The results of the power-on diagnostics are erased from the screen, but you can view the results by selecting **CONFIG > Utilities > View Diagnostics Log > SEL**.
4. After the diagnostics are finished, the instrument state is restored. When the progress indicator in the status bar is finished, the instrument has finished initializing.
5. Record Pass or Fail for the POST (Power On Self Test) in the test record.
6. If it is still open, exit the Diagnostics Log.

Restore the Factory Presets

1. Follow these steps to reset the instrument to the Factory Presets:
   a. Press and hold the **PRESET** button.
   b. Select **Recall Preset > Recall Factory Preset**.
   c. Press the **SEL** button.

Set Thumbnail/Display Select Button for Tile Navigation

1. Follow these steps to set the **Thumbnail** button for tile navigation:
   a. Press and hold the **Main** button.
   b. Select **Multi-Button**.
   c. Press the **SEL** button to highlight and select **Disp. Sel**.
   d. Press the **Main** button to dismiss the pop-up menu.
2. To toggle between 4-tile and full screen views of the active tile, press and hold the **Thumbnail** button.

Front Panel Test

1. Set the instrument to the Factory Presets. (See page 32, *Restore the Factory Presets*.)

   Wait for the process to complete as indicated by the progress indicator. Record Pass or Fail in the test record.
2. Connect a 525/270 color bar signal from the TG700 DVG7 to the SDI 1A input.
3. Turn the **Horz** (horizontal) and **Vert** (vertical) knobs and verify the waveform moves appropriately.
4. Press **HELP** to display the online help.
5. Press each of the front panel buttons, except for the **HELP** and **POWER** buttons.

   Each button should flash as you press it. Most buttons will bring up help text related to that button in the right pane of the help screen. Some buttons, such as the presets, all bring up the same information, so you may need to alternate between preset buttons and another button to see the text change. The navigation keys (the four arrow keys and the **SEL** key) do not bring up help text. They are used to navigate the help panes and content.
6. Press the right arrow key until the Help Contents pane in the upper-left corner is highlighted.
7. Turn the **General** knob and verify the selector box moves up and down the list of topics.
8. Press **HELP** to exit help.
9. Record Pass or Fail for Front Panel Test in the test record.

LCD Pixel Defects

1. Set the instrument to display a white screen:
   a. Press the **CONFIG** button.
   b. Select **Utilities > Screen Solid Color > Select Color > White**.
   c. Press the **SEL** button.
2. Count any pixels stuck low (not white).
3. While the screen is all white, inspect for visible defects that exceed the limits. (See Table 44.)

NOTE. Inspection should be done from 18″ away from the display, under normal room lighting. Loose dust on the front of the screen does not constitute a defect.

4. Press the **SEL** button to cancel the white screen.
5. Set the instrument for an all black screen:
   a. Select **Utilities > Screen Solid Color > Select Color > Black**.
   b. Press the **SEL** button.
6. Count any pixels stuck high (not black).
7. Press the **SEL** button to cancel the black screen.
8. Check that the total number of pixels counted in steps 2 and 6 is less than six.

Table 44: LCD visual defects

Defect type [1]	Allowable defect	
Circular Defect [2]	>0.020″	None
	0.015″ to 0.020″	Maximum of two allowed within a 2I circle
Black Defect (opaque)	>0.005″	None
Linear Defect (Scratches)	>0.004″ width	None
	0.003″ to 0.004″wide	Max length 0.500″
	0.0021″ to 0.0030″wide	Max length 1.000″
	0.0010″ to 0.0020″wide	Max length 1.500″
Stains, discolorations, streaks, scuffs	Allowed if they fade when backlit	

1 Defects should be visible from 18" under normal lighting. If you have to hold it closer or use special lighting to see the defect, it is not a rejectable defect.

2 For irregular defects, use (LengthxWidth)/2.

9. Record pass or fail for Pixel Defect in the test record.
10. Press the **CONFIG** button to close the configuration menu.

Diagnostics Test

1. Run the Diagnostics:
   a. Press the **CONFIG** button.
   b. Select **Utilities > Run Diagnostics**.
   c. Press the **SEL** button. The diagnostics screen will appear.
   d. Use the left/right arrow keys to select "Run Power Up Diagnostics", then press **SEL**.
2. Verify that all the tests have a green Pass status. Record pass or fail for "Power Up Diagnostics" in the test record.
3. Use the left/right arrow keys to select "Run Advanced Diagnostics", then press **SEL**.
4. Verify that all the tests have a green Pass status. Record pass or fail for "Advanced Diagnostics" in the test record.

Fan Test

You should be able to hear the fans and feel air coming out the back of the instrument. At low temperatures the fans will turn slowly and be very quiet. Record Pass or Fail for Fan Test in the test record.

SDI Input Operation Test

1. Set the video test generator to output the following SDI signals:
   a. 270 Mb/s: 525i 59.94, 100% Color Bars, Group 1 embedded audio ON
   b. 1.5 Gb/s: 1080i 59.94, 100% Color Bars, Group 1 embedded audio ON
   c. (Option 3G only) 3 Gb/s: 3G Level A, 1080p 59.94 YCbCr 10 bit, 100% Color Bars, Group 1 embedded audio ON
2. Perform the following steps to set the TG700 DVG7 module (270 Mb/s):
   a. Restore the Factory Preset.
   b. Press the **MODULE** button until DVG7 appears.
   c. Press the **FORMAT** button until 525-270 appears and then press **ENTER**.
   d. Press the **CANCEL** button.
   e. Press the up/down arrows until Audio (Embedded) appears. If Group 1 is not indicated then press the right/left arrows until Group 1 appears. Press **ENTER**.

f. Use the right/left arrows until Status: Enable appears, then press **ENTER**.

g. Repeatedly press the **COLOR BAR** button until 100% Color Bars appears.

3. Perform the following steps to set the TG700 HDVG7 module (1.5 Gb/s):

a. Press the **MODULE** button until HDVG7 appears.

b. Press the **FORMAT** button until 1080 59.94i appears and then press **ENTER**.

c. Press the **CANCEL** button.

d. Press the up/down arrows until Audio (Embedded) appears. If Group 1 is not indicated then press the right/left arrows until Group 1 appears. Press **ENTER**.

e. Use the right/left arrows until Status: Enable appears, then press **ENTER**.

f. Repeatedly press the **COLOR BAR** button until 100% Color Bars appears.

4. (Option 3G only) Perform the following steps to set the TG700 HD3G7 module (3 Gb/s):

a. Press the **MODULE** button until HDVG7 appears.

b. Press the **FORMAT** button until 1080 59.94p appears and then press **ENTER**.

c. Press the **CANCEL** button.

d. Press the up/down arrows until Audio (Embedded) appears. If Group 1 is not indicated then press the right/left arrows until Group 1 appears. Press **ENTER**.

e. Use the right/left arrows until Status: Enable appears, then press **ENTER**.

f. Repeatedly press the **COLOR BAR** button until 100% Color Bars appears.

5. Connect the 525/270 color bar signal from the DVG7 to the SDI 1A input. Connect the SDI Out to the input of a waveform monitor that has 270 Mb/s EDH/CRC check capability.

6. Set the instrument under test to the Factory Preset. (See page 32, *Restore the Factory Presets*.)

7. Press and hold the **STATUS** button. Select **Display Type > Video Session**. Press **STATUS** to close the pop-up menu.

8. A 4-tile display consisting of waveform, video session status, picture, and audio level bars (if option AUD is installed) should appear. Check that:
   a. The waveform display shows a stable YPbPr parade, with all three components present and each being 700 mVp-p.
   b. The Video Session screen indicates “OK” for CRC errors.
   c. A full field color bar waveform appears in the Picture display.
   d. Audio bars appear for Channels 1-4 (nominally at –20 dBFS), if the audio option is present.
   e. The lower left corner readout indicates “525i 59.94”.
9. On the instrument under test, check that a color bar signal is being received and that no EDH/CRC errors are present.
10. Record Pass or Fail for SDI 1A, 270 Mb/s in the test record.
11. Move the generator test signal from the SDI 1A input to the SDI 1B input. Select input **1B**.
12. Repeat steps 8 and 11 above. Record pass or fail for SDI 1B, 270 Mb/s in the test record.
13. Connect the 1.5 Gb/s 1080i/59.94 color bar signal from the HDVG7 to the SDI 1B input. Connect the SDI Out to the input of a waveform monitor that has 1.5 Gb/s CRC check capability. Input **1B** should be selected.
14. A 4-tile display consisting of waveform, video session status, picture, and audio level bars should appear. Check that:
   a. The waveform display shows a stable YPbPr parade, with all three components present and each being 700 mVp-p.
   b. The Video Session screen indicates “OK” for CRC errors.
   c. A full field color bar waveform appears in the Picture display.
   d. Audio bars appear for Channels 1-4 (nominally at –20 dBFS), if the audio option is present.
   e. The lower left corner readout indicates “1080i 59.94”.
15. On the instrument under test, check that a color bar signal is being received and that no CRC errors are present.
16. Record Pass or Fail for SDI 1B, 1.5 Gb/s in the test record.
17. Repeat steps 16 through 17 above for the SDI 1A input. Record Pass or Fail for SDI 1A, 1.5 Gb/s in the test record. Skip to the next section unless Option 3G is installed.

18. (Option 3G only) Connect the 3 Gb/s 1080p/59.94 color bar signal from the HD3G7 to the SDI 1A input. Connect the SDI Out to the input of a waveform monitor that has 3 Gb/s CRC check capability. Input 1A should be selected.

19. A 4-tile display consisting of waveform, video session status, picture, and audio level bars should appear. Check that:

    a. The waveform display shows a stable YPbPr parade, with all three components present and each being 700 mVp-p.

    b. The Video Session screen indicates “OK” for CRC errors.

    c. A full field color bar waveform appears in the Picture display.

    d. Audio bars appear for Channels 1-4 (nominally at –20 dBFS), if the audio option is present.

    e. The lower left corner readout indicates “1080p 59.94”.

20. On the instrument under testr, check that a color bar signal is being received and that no CRC errors are present.

21. Record Pass or Fail for SDI 1A, 3Gb/s in the test record.

22. Repeat steps 19 and 20 above for the SDI 1B input. Record Pass or Fail for SDI 1B, 3 Gb/s in the test record.

23. Repeat this entire procedure for SDI Input 2A and SDI Input 2B.

Waveform Signal Path Stuck Bit Test.

1. Connect a 1.5 Gb/s 1080i 59.94 10-bit shallow ramp matrix signal from the HDVG7 module to the SDI 1A input of the instrument under test. (The shallow ramp matrix signal can be found under the LINEARITY button).

2. Set the instrument to Factory Presets. (See page 32, *Restore the Factory Presets*.) A YPbPr parade should be displayed in Tile 1.

3. Turn off the Pb waveform:

    a. Press and hold the **WFM** button to display the waveform menu.

    b. Select **Pb**.

    c. Use the **SEL** button to select **Off**.

    d. Press the **WFM** button to close the menu.

4. Press and hold the **Display Select** button to expand the waveform tile to full screen.

5. Inspect the Y and Pr waveforms. Each should contain a series of equally spaced shallow ramps. Each ramp should increase monotonically. Stuck

bits will show as coarse steps or discontinuities in the ramps. The standard HDVG7 signal set will show 11 ramps of 70 mV each.

a. Press and hold the **GAIN** button to display the Gain menu.

b. Select **Gain Settings**.

c. Use the arrow keys to select **x10**.

d. Press the **GAIN** button once to close the Gain menu. The **GAIN** button should remain lit.

6. Inspect one shallow ramp in each of the Y and Pr waveforms. Small steps will be visible in the ramp. The steps should always step upward in equal increments over the entire ramp. Check for 11 to 13 even vertical steps over a major division (10 mV).
7. Press the **GAIN** button to return the instrument to x1 gain.
8. Change the input signal to a 100% sweep 1-15 MHz.
9. Verify that the sine waves are uniform and do not have steps. Also check that the amplitude is 700 mV.
10. Move the input signal to the SDI 1B input and press the Input **1B** button. Select the shallow ramp matrix on the test signal generator.
11. Repeat steps 5 through 9 for the SDI 1B input.
12. Record Pass or Fail for the Waveform Stuck Bit Test in the test record.
13. Repeat this entire procedure for SDI Input 2A and SDI Input 2B.

External Reference

1. Restore the Factory Preset. (See page 32, *Restore the Factory Presets*.)
2. Connect a 525/270 color bars signal from a DVG7 module to the SDI 1A input of the instrument under test.
3. Apply an NTSC 0% Flat Field signal from an AVG7 module to the EXT REF input of the instrument under test. The AVG7 and DVG7 must be installed in the same TG700 mainframe or, if not, the signals must be genlocked. Install a 75 Ω termination on the other side of the EXT REF loop-through.
4. Press **EXT REF** on the instrument front panel.
5. The status bar in the lower left-hand corner of the display should display Ref: NTSC.
6. Verify that the waveform displayed in tile 1 is stable.
7. Record Pass or Fail for NTSC Lock in the test record.
8. Change the signal applied to the EXT REF input to NTSC 100% Flat Field.
9. Press and hold the **OTHER** button, then select **Ext Ref Waveform**.

10. Press the **OTHER** button briefly to dismiss the menu.
11. Check that there is a stable display of the 100% flat field signal.
12. Use the Vertical knob to center the sync tip over the -40 IRE graticule line. (Sync tip is the most negative section of the waveform.)
13. Check that the top of the waveform lies between 90 IRE and 110 IRE using the left vertical scale.
14. Record Pass or Fail for External Reference Waveform in the test record.
15. Press the **WFM** button to display the SDI color bars waveform.
16. Remove the NTSC signal from the EXT REF input.
17. The waveform displayed in tile 1 should "unlock" and scroll.
18. The status bar in the lower left-hand corner of the display should display Ref: Ext. Missing.
19. Record Pass or Fail for Ref Missing in the test record.

Digital Audio Input (Option AUD)

1. Set the video test signal generator to output a 270 Mb/s 525 line color bar signal with Group 1 and 2 embedded audio set as follows:
   - Group 1, Channel 1 (Ch 1): 50 Hz, –35 dBFS
   - Group 1, Channel 2:(Ch 2): 100 Hz, –30 dBFS
   - Group 1, Channel 3 (Ch 3): 150 Hz, –25 dBFS
   - Group 1, Channel 4 (Ch 4): 200 Hz, –20 dBFS
   - Group 2, Channel 1 (Ch 5): 250 Hz, –15 dBFS
   - Group 2, Channel 2 (Ch 6): 300 Hz, –10 dBFS
   - Group 2, Channel 3 (Ch 7): 400 Hz, –5 dBFS
   - Group 2, Channel 4 (Ch 8): 500 Hz, 0 dBFS

   If using a TG700 DVG7 module, use the following procedure to configure the embedded audio:

   a. Press **MODULE** repeatedly until DVG7 is displayed.
   b. If 525-270 does not show, press **FORMAT** repeatedly until 525-270 is displayed and then press **ENTER**.
   c. Press **CANCEL** to return to the top menu.
   d. Press the up/down arrow keys until AUDIO (EMBEDDED) is displayed. Use the left/right arrow keys to select "Group 1", then press **ENTER**.
   e. Press the up/down arrow keys until "Status" is displayed, then use the left/right arrow keys to select "Enable", then press **ENTER**.

NOTE. It is important to press the Enter key even if Status: Enable is displayed, to ensure that the Embedded Audio is actually turned on.

f. Press the up/down arrow keys until “Channel” is displayed. Then press the left/right arrow keys until “Channel 1” appears. Press **ENTER**.

g. Press the up/down arrow keys until “Frequency” is displayed. Press the left/right arrow keys to select “50 Hz”, then press **ENTER**.

h. Press the up/down arrow keys until “Amplitude” is displayed. Use the left / right arrow keys to select “–35 dBFS”, then press **ENTER**.

i. Press the **CANCEL** key once to return to AUDIO:GRP-1:Channel. Use the left/right keys to select Channel:2, then press **ENTER**.

j. Following the procedure in steps g through i above, set channels 2, 3, and 4 to the values shown at the start of step 1.

k. After setting channels 1–4, press **CANCEL** twice to return to AUDIO (EMBEDDED). Press the left/right arrow keys to select “Group 2”, then press **ENTER**.

l. Enable the Group 2 audio, following step e above.

m. Set Channels 1 through 4 in Group 2 to the values shown at the start of step 1, following the procedure in steps g through i above.

n. Press **CANCEL** twice to return to the AUDIO (EMBEDDED) menu.

o. Press **COLOR BAR** to return to the top level menu and select a color bar signal.

2. Connect the output of the DVG7 to the SDI 1A input of the instrument under test.

3. Set the **Thumbnail** button for tile navigation. (See page 32, *Set Thumbnail/Display Select Button for Tile Navigation*.)

4. Press the **Display Select** (Thumbnail) button and select tile 4.

5. Press and hold the **AUDIO** button to display the Audio pop-up menu.

6. Select **Audio Input > Embedded**.

7. Press the **AUDIO** button to clear the menu.

8. Verify that the level meter bars have a stair step pattern from –35 dB on channel 1 to 0 dB on channel 8.

9. Press the **AUDIO** button to clear the menu.

10. Record Pass or Fail for Embedded to Bar Display in the test record.

11. Press and hold the **AUDIO** button to display the AUDIO pop-up menu.

12. Select **Aux Display > Phase Display**.

NOTE. If you do not see the Phase Display, press the Display Select/Thumbnail button to view the Audio Display full-screen. To view the Phase Display in 4-Tile mode, check that the other tiles have non-waveform display in them.

13. Press the left arrow key once.
14. Select **Phase/Headphone Pair > 1 & 2**.
15. Go through the other phase pairs (3 & 4, 5 & 6, 7 & 8) and verify that the phase display changes as each pair is selected.
16. Record Pass or Fail for Embedded to Lissajous Display in the test record.

LTC Waveform and Decode Test

1. Restore to Factory Presets. (See page 32, *Restore the Factory Presets*.)
2. You will need a custom cable for this step.
   a. Make a shielded coaxial cable with a male RCA connector on one end. On the other end connect the coax center conductor to pin 7 and the outer shield conductor to pin 8 of a male HD-15 connector.
3. Connect the RCA connector on the custom cable to the output of the Timecode generator. Connect the 15-pin connector to the REMOTE connector on the instrument rear panel.
4. Connect the TG700 AVG7 CH1 output to the video input of the Timecode generator. Select any NTSC signal.
5. Connect a 525/270 color bar signal from the DVG7 module to the SDI A input of the instrument under test.

NOTE. The DVG7 and AVG7 must be installed in the same TG700 mainframe so that their outputs are synchronous.

6. Press **CONFIG**.
7. Select **Aux Data Settings > Timecode Source > LTC**.
8. Press the **OTHER** button to display the LTC waveform.
9. The LTC waveform should be displayed in the active tile. The amplitude will depend on the source. The sync packet should remain at a constant horizontal location on the sweep.
10. Record Pass or Fail for the LTC waveform in the test record.

11. In the lower-right corner of the screen, the time from the LTC input should be shown. It may be necessary to reset the LTC generator by using the reset switch.
12. Record Pass or Fail for LTC Decode in the test record.
13. Disconnect the LTC generator.

Ground Closure Remote

1. Connect a 525/270 color bar signal to the SDI 1A input.
2. You will need a custom cable for this step.
   a. Solder wires to pins 1, 2, 5, 6, 7, 8, and 9 of a male DB9 connector, and strip the insulation back approximately 1/4 inch on each of the wires.
3. Connect the HD-15 connector to the REMOTE connector on the instrument.

Preset Recall Test.

4. Restore the Factory Preset. (See page 32, *Restore the Factory Presets*.)

NOTE. *This test overwrites presets A1 through A4. Save any existing presets to USB flash memory before doing this procedure.*

5. Set the instrument to display a picture in tile 1 and a waveform in the remaining tiles (WFM, VECTOR, and GAMUT).
6. Save the current settings as preset A1:
   a. Press and hold the **PRESET** button to display the Preset Menu.
   b. Select **Save Preset > Select Group A > Save A1**.
   c. Press **SEL** to save the preset.
   d. Briefly press the **PRESET** button to close the Preset menu.
7. Repeat steps 5 and 6 to create a preset with picture in tile 2 and waveform in tiles 1, 3, and 4. Save as Preset **A2**.
8. Repeat steps 5 and 6 to create a preset with picture in tile 3 and waveform in tiles 1, 2, and 4. Save as Preset **A3**.
9. Repeat steps 5 and 6 to create a preset with picture in tile 4 and waveform in tiles 1, 2, and 3. Save as Preset **A4**.
10. Repeat steps 5 and 6 to create a preset with picture in tiles 1 and 4 and waveform in tiles 2 and 3. Save as Preset **A5**.
11. Repeat steps 5 and 6 to create a preset with picture in tiles 2 and 4 and waveform in tiles 1 and 3. Save as Preset **A6**.

12. Set the instrument to the factory presets. (See page 32, *Restore the Factory Presets*.)
13. Short pins 1 and 10 together on the remote cable.
14. Preset **A1** should be restored so that a picture is displayed in tile 1.
15. Short pins 1 and 11 together on the remote cable.
16. Preset **A2** should be restored so that a picture is displayed in tile 2.
17. Short pins 1 and 12 together on the remote cable.
18. Preset **A3** should be restored so that a picture is displayed in tile 3.
19. Short pins 1 and 13 together on the remote cable.
20. Preset **A4** should be restored so that a picture is displayed in tile 4.
21. Short pins 1 and 14 together on the remote cable. Preset **A5** should be restored with a picture in tiles 1 and 4.
22. Short pins 1 and 15 together on the remote cable. Preset **A6** should be restored with a picture in tiles 2 and 4.
23. Record Pass or Fail for Activate Preset in the test record.
24. Restore saved presets from the USB flash memory device (if saved before this procedure).

Ground Closure Alarm Test.

25. Connect a 525/270 color bar signal from the DVG7 to the SDI 1A input.
26. Restore the Factory Preset. (See page 32, *Restore the Factory Presets*.)
27. On a 15-pin, male HD-15 connector, solder wires or strip back insulation to gain access to pins 1 and 9 (pin 1 is a ground and pin 9 is the ground closure output signal).

NOTE. *You can use the test cable prepared for the previous step.*

28. Connect the HD-15 connector to the REMOTE connector on the instrument.
29. Press the **CONFIG** button to display the CONFIG menu.
30. Select **Alarms > SDI Input**, then press the **SEL** button.
31. Use the arrow keys to move the selection highlighting to the **Ground Closure** column of the **SDI Input Missing** row, and then press **SEL** to put an X in the box. This instructs the instrument to assert the ground closure if the input is not present.

32. Connect the voltmeter (+) lead to the pin 9 wire and the (–) lead to the pin 1 wire. The voltmeter should read about 4.7 V.
33. Remove the video signal from the SDI 1A connector to assert the ground closure.
34. The voltmeter should now read a low voltage, below 0.5 V.
35. Record Pass or Fail for Ground Closure Alarm in the test record.

Ethernet Test

1. Connect the instrument's Ethernet port to a computer that has a web browser installed. You can use a Local Area Network (LAN) to interconnect the instrument and computer, or directly connect the instrument and computer Ethernet ports. LAN interconnection is recommended as this simplifies setting the IP address.
2. To interconnect with a LAN:
   a. Connect both the instrument and the computer to LAN ports using Ethernet cables.
   b. Press the **CONFIG** button to display the Configuration menu.
   c. Select **Network Settings > IP Config Mode**.
   d. Select **DHCP**. In this mode the network will assign an IP address to the instrument. The address fields should momentarily read "Waiting on DHCP" before the assigned addresses appear.
3. To use a direct connection between the instrument and computer:
   a. Connect the instrument and computer with an Ethernet cable. Either a direct or crossover cable may be used.
   b. Select compatible IP addresses for the instrument and computer. Either or both addresses may be changed. A suggested approach is to set the addresses the same for the first three fields, then setting the last field one digit different. For example:

      Instrument: 192.168.001.001
      Computer: 192.168.001.002

      NOTE. *On most Windows computers, using the command "ipconfig" in the Command Prompt window will show the computer IP address value. It may be manually set via Control Panel > Network Connections.*

   c. To change the IP address on the instrument, press **CONFIG** and select **Network Settings > IP Config Mode > Manual**. Now select **Network Settings > IP Address**. Use the left/right arrow keys to move the highlight to each box in the address. Use the up/down arrow keys to change the

number in each box as required. Accept the changes by moving the highlight to the Accept box and press **SEL**.

4. Enable the instrument Web access from the Configuration menu by selecting **Network Settings > Web Enable > On**.
5. Open a Web browser on the computer.
6. From the computer, enter the IP address of the instrument into the Web browser address line (for example, http://192.168.1.1). This is the address that appears in the field **CONFIG > Network Settings > IP Address**. Note that leading zeros are deleted in the address line.
7. You should see a Web page titled "Tektronix WFM5200 Interface" or something similar. This means the Ethernet function is working.
8. Record Pass or Fail for Ethernet Functionality in the test record.

Dual Link Format Verification Test

1. Set up a dual link signal generator (TG700 with HDLG7 module). Connect the Link A output on the module to the SDI 1A input of the instrument, and the Link B output to the SDI 1B input of the instrument.
2. Perform the following steps to set the HDLG7 module format to 1080 59.94i:
   a. Press the **MODULE** button until HDLG7 appears.
   b. On the signal generator, press the **FORMAT** button until 1080 59.94i appears and then press the **ENTER** button.
   c. Press the **CANCEL** button.
   d. Press the up/down arrows until Sample Structure/Depth appears.
   e. Press the left/right arrows until "YCbCr+A 4:4:4 10 bits" appears.
   f. Press the **ENTER** button.
   g. Press the **COLOR BAR** button until 100% color bars appears.
3. Restore the Factory Preset. (See page 32, *Restore the Factory Presets*.)
4. Press the **Display Select** (Thumbnail) button and select tile 4.
5. Press and hold the **STATUS** button.
6. Select **Display Type > Video Session**.
7. Press the **Display Select** (Thumbnail) button and select tile 2.
8. Press and hold the **VECTOR** button to display the Vector menu.
9. Select **Display Type > Lightning**.
10. Press the **VECTOR** button to close the menu.

11. Verify that the following are true in the specified tile or area:

- Tile 1: YPbPrA parade waveform is displayed
- Tile 2: Endpoints of Lightning display land within targets
- Tile 3: Color bars picture displayed
- Tile 4: Format indicates Auto 1080i 59.94 YCbCrA 4444 10 bit

12. On the signal generator, check that HDLG7 is displayed. Press the **CANCEL** button and then press the arrow button to select Sample Structure/Depth. Next, press the left arrow button to change the HDLG7 color space from YPbPr to GBR 4:4:4 10 bit.

13. Press the **ENTER** button.

14. Verify that the following are true in the specified tile or area:

- Tile 1: YPbPr parade waveform displayed and automatically converted from RGB input signal
- Tile 2: Endpoints of Lightning display land within targets
- Tile 3: Color bars picture displayed
- Tile 4: Format indicates RGB 444 10 bit

15. Record Pass or Fail in the test record.

Video and General Performance Verification Procedures

This performance verification includes procedures that verify standard and option-equipped instruments.

Required Equipment

Table 45: Required test equipment (video and general performance)

Test equipment	Requirements	Example
Video test signal generator	1080p 59.94 3Gb/s HD signals (required for option 3G) ■ 100% color bars ■ SDI Matrix Split Field Pathological Signal	Tektronix TG700 with HD3G7 module
	1080i 59.94 1.5Gb/s HD signals ■ 100% color bars ■ SDI Matrix Split Field Pathological Signal	Tektronix TG700 with HDVG7 module
	625i 50 270 Mb/s SD signals ■ 100% color bars 525i 59.94 270 Mb/s SD signals ■ 100% color bars ■ SDI Matrix Split Field Pathological Signal	Tektronix TG700 with DVG7 module
SD “Cable Clone” cable simulator	Simulate 0 to 300 meters of Belden 8281 equivalent in 25 meter steps.	Faraday SC75A800B-G
HD “Cable Clone” cable simulator	Simulate 0 to 150 meters of Belden 8281 equivalent in 10 meter steps, 300 kHz to 1.5 GHz range.	Faraday FFC010A075, FFC020A075, FFC040A075, and FFC080A075 (available as a boxed set of 4).
3G “Cable Clone” cable simulator	Simulate 0 to 150 meters of Belden 1694A equivalent in 10 meter steps, 0.3 MHz to 3 GHz range (required for option 3G).	Faraday FFE010D075, FFE020D075, FFE040D075, and FFE080D075 (available as a boxed set of 4).
75 Ω coaxial cables (3 required)	RG-6 type coaxial cable with male BNC connectors, 1 to 2 meters long, suitable for use to 1500 MHz.	Belden 8281 or 1694A. Tektronix part numbers 012-0159-00 or 012-0159-01.

Table 45: Required test equipment (video and general performance) (cont.)

Test equipment	Requirements	Example
Digital Multimeter	At least 3 ½ digits, 0.1% or better DC voltage measurement accuracy at 700 mV.	Fluke model 83
Test Oscilloscope	>3 GHz bandwidth with 75 Ω input, >20 dB input return loss to 3 GHz, ±3.5% or better vertical gain accuracy.	Tektronix DPO70404 with TCA75 Impedance Conversion Adapter.

NOTE. *Use a DVI-A adapter if you are connecting to an XGA monitor with a 15-pin RGBHV analog interface.*

Basic Setup

Use the following setup for all tests unless otherwise specified.

1. Connect the power cord to the rear of the instrument.
2. Connect an XGA monitor to rear of instrument.
3. Connect the power cord to the AC mains and allow at least 20 minutes for the instrument to warm up before beginning any procedures.

Instrument Tests

The following procedures apply to all base instruments except where labeled for specific models. Do all tests except those that exclude your model.

Connect the power cord to the AC mains and allow at least 20 minutes for the instrument to warm up before beginning any procedure.

SDI Input Equalization Range

This test uses a cable clone to simulate cable. This verifies that the instrument can receive signals that have passed through long cables.

All models have an SDI interface with four inputs. Each SDI input should be checked.

270 Mb/s checks.

1. Set the instrument to the factory presets. (See page 32, *Restore the Factory Presets*.)
2. Connect the TG700 DVG7 SIGNAL 1 output to the SDI 1A input.

NOTE. *All signal connections are made with 75 Ω digital video coaxial cables.*

3. Set the DVG7 to 525-270 format. Select the “100% Color Bars” signal. A Color Bar signal should be displayed by the instrument.
4. Press the **Display Select** (Thumbnail) button and select tile 2.
5. Press and hold the **STATUS** button, select **Display Type** and then **Video Session**. Press the **STATUS** button to dismiss the menu.
6. Connect the cable clones as follows:
   a. Disconnect the DVG7 from the SDI 1A input. Connect the DVG7 SIGNAL 1 output to the SD Cable Clone Input.
   b. Use a second cable to connect the SD Cable Clone Output to the 80 m section of the HD Cable Clone Input (FFC model, Belden 8281, 300 kHz to 1.5 GHz).
   c. Connect the HD Cable Clone Output directly to the SDI 1A input.

NOTE. *It is important to use the combination of SD and HD cable clones as described. Some SD cable clones do not properly simulate cable loss at very high frequencies. This can cause modern multi-rate SDI Equalizer circuits to malfunction. The 80 m HD Cable Clone isolates the Equalizer from the SD Cable Clone. If desired, an 80 m length of actual Belden 8281 coax can be substituted for the HD Cable Clone.*

7. Set all switches on the Cable Clone to the “out” position.
8. You should see a stable picture and waveform on the display. The FF and AP CRC Status on the Video Session screen should both read OK.
9. Adjust the cable clone switches to find the longest length of “cable” that does not generate any CRC errors in a 10 second period.
10. Read the switch settings to calculate the equivalent length of 8281 coax. To this value add 80 m for the HD Cable Clone. This sum is the total length of simulated 8281 cable.
11. Divide the total length of Belden 8281 cable by 10 to calculate the attenuation in dB at 135 MHz.
12. Record the value in the test record. Acceptable performance is 22 dB or greater.
13. Starting from 6c, repeat the test for the SDI 1B input (Front Panel input **1B**).
14. Repeat this procedure for SDI input 2A and 2B starting at step 6c.

1.5 Gb/s checks.

1. Connect the TG700 HDVG7 SIGNAL 1 output to the SDI 1A input.
2. Set the HDVG7 to 1080 59.94i format. Select the “100% Color Bars” signal. On the instrument select input **1A** . A Color Bar signal should be displayed.
3. Disconnect the HDVG7 from the SDI 1A input. Connect the cable from the HDVG7 to the 80 m HD Cable Clone Input (FFC model, Belden 8281, 300 kHz to 1.5 GHz).
4. Using a 75 Ω female-to-female BNC adapter and a second cable, connect the Cable Clone Output to the SDI 1A input.

NOTE. *The 75 Ω BNC adapter should be included with the cable clone set.*

5. Select the “SDI Matrix” signal from the TG700 HDVG7.
6. You should see a stable picture and waveform on the instrument display. The Y Chan and C Chan CRC Error Status on the Video Session screen should both read OK.
7. Connect additional sections of the HD Cable Clone into the signal path to find the longest length of “cable” that does not generate any CRC errors in a 10-second period.
8. The HD Cable Clone set described in the Required Equipment List simulates up to 150 m of Belden 8281 when all four sections are connected. If your instrument does not appear to show CRC errors at this simulated cable length, reset the CRC Err Secs readout to zero (refresh the active display by pressing a different display button and then returning to the current display). After 60 seconds, check the CRC Err Secs readouts. A “0” reading for both CRCs indicates that the Cable Accommodation range is ≥150 m of Belden 8281.

NOTE. *If additional HD Cable Clone sections are available, the test may be continued to find the point where CRC errors occur.*

9. Add the HD Cable Clone section lengths to get the total length in meters of Belden 8281 cable. Divide by 4 to calculate attenuation in dB at 750 MHz.
10. Record the value in the test record. Acceptable performance is 28 dB or greater.
11. Starting from step 3, repeat the test for the SDI 1B input (Front Panel input **1B**).
12. Repeat this procedure for SDI input 2A and 2B starting at step 3.

3 Gb/s checks (Option 3G only).

1. Connect the TG700 HD3G7 SIGNAL 1 output to the SDI 1A input.
2. Set the HD3G7 to 1080 59.94p format. Select the "100% Color Bars" signal. On the instrument select input **1A**. A Color Bar signal should be displayed.
3. Disconnect the HD3G7 from the SDI 1A input. Connect the cable from the HD3G7 to the 80 m 3G Cable Clone Input (FFE model, Belden 1694A, 0.3 MHz to 3 GHz).
4. Using a 75 Ω female-to-female BNC adapter and a second cable, connect the Cable Clone Output to the SDI 1A input.

NOTE. *The 75 Ω BNC adapter should be included with the cable clone set.*

5. Select the "SDI Matrix" signal from the TG700 HD3G7.
6. You should see a stable picture and waveform on the instrument display. The Y Chan and C Chan CRC Error Status on the Video Session screen should both read OK.
7. Connect additional sections of the 3G Cable Clone into the signal path to find the longest length of "cable" that does not generate any CRC errors in a 10-second period.
8. The 3G Cable Clone set described in the Required Equipment List simulates up to 150 m of Belden 1694A when all four sections are connected. If your instrument does not appear to show CRC errors at this simulated cable length, reset the CRC Err Secs readout to zero (refresh the active display by pressing a different display button and then returning to the current display). After 60 seconds check the CRC Err Secs readouts. A "0" reading for both CRCs indicates that the Cable Accommodation range is ≥150 m of Belden 1694A.

NOTE. *If additional 3G Cable Clone sections are available, the test may be continued to find the point where CRC errors occur.*

9. Add the 3G Cable Clone section lengths to get the total length in meters of Belden 1694A cable. Divide by 4 to calculate attenuation in dB at 1500 MHz.
10. Record the value in the test record. Acceptable performance is 28 dB or greater.
11. Starting from step 3, repeat the test for the SDI 1B input (Front Panel input **1B**).
12. Repeat this procedure for SDI inputs 2A and 2B starting at step 3.

This completes the SDI Input Equalization Range checks.

SDI Serial Output Amplitude

This test verifies that the Serial Output signal amplitude is within specifications.

All instruments have an SDI OUT signal output on the rear panel. The content of this signal is determined by the **Config> Outputs> SDI Output** setting.

Serial output check (all models).

1. Set the instrument to the Factory Preset.
2. Connect the TG700 DVG7 SIGNAL 1 output to the SDI 1A input on the instrument.
3. Set the DVG7 to provide a 525 270 Mb/s 100% color bar signal.
4. Input **1A** should be selected on the instrument. You should see a stable color bar picture and waveform display.
5. Install the TCA75 adapter in the test oscilloscope CH 1 input. Connect the instrument SDI OUT to the oscilloscope CH 1 input.
6. Set the test oscilloscope as follows:

Parameter	Setting
CH 1 Vertical	Scale: 200 mV/div
	Position: 0.0 div
	Offset: 0.0 div
	Coupling: DC
	Bandwidth: 4.0 GHz
Horizontal:	Mode: Automatic
	Scale: 2 ns/div
	Delay mode: Off
FastAcq:	On/DPX
Trigger: A Event	Trigger Type: Glitch
	Source: CH 1
	Level: 0.0 V
	Width: 6.7 ns
	Glitch Width: Greater Than
	Polarity: Either
	Trigger if Glitch: Occurs
Trigger: A>B Seq	A only

7. Activate the test oscilloscope “H Bars” cursors. Set Cursor 1 to the middle of the bottom trace and Cursor 2 to the middle of the upper trace. Use the 7 ns wide region that does not contain transitions to align the cursors. See the following figure.

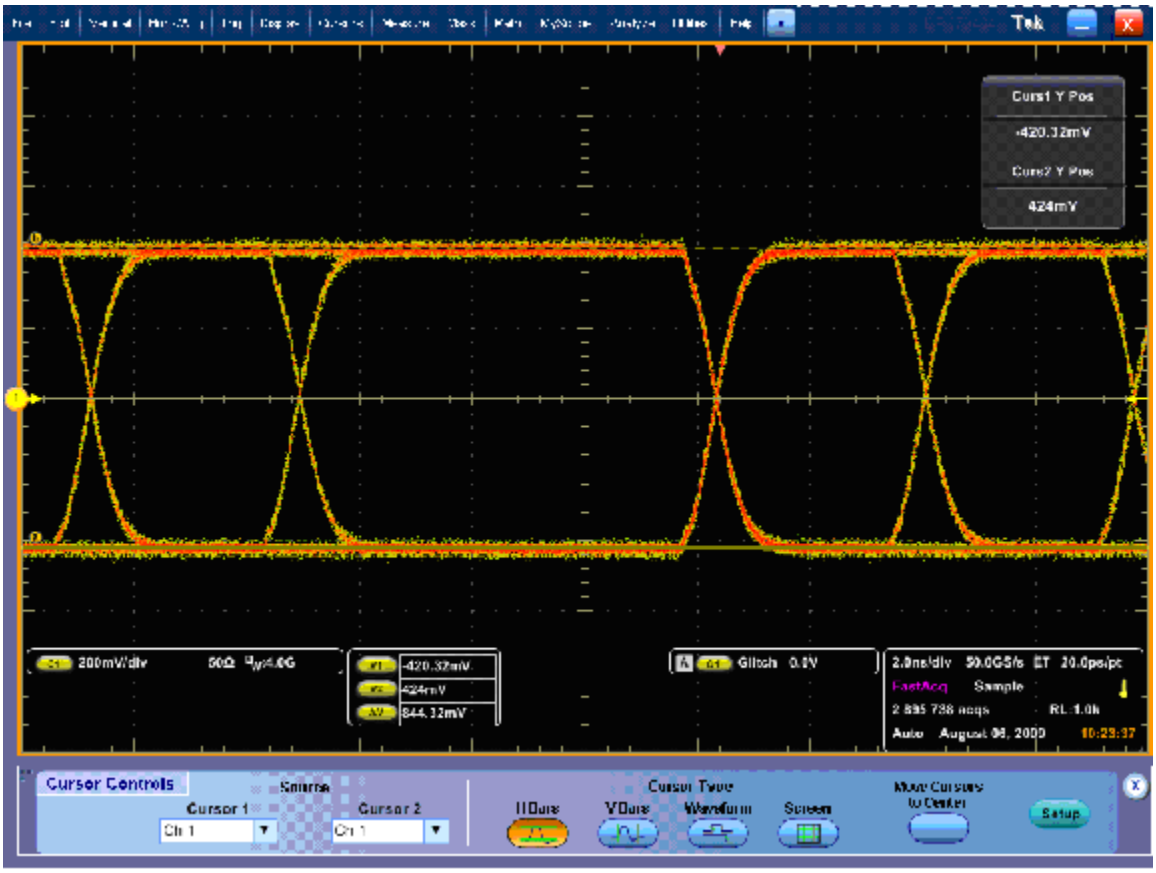

Figure 1: Serial Output at 270 Mb/s, using Glitch Trigger mode

8. Record the amplitude (ΔV) in the test record for 270 Mb/s. Amplitudes between 745 mV and 849 mV are acceptable.

NOTE. *The specification range for the SDI outputs is 720 mV to 880 mV (800 mV ±10%). The test limits are narrower than this to allow for the ±3.5% amplitude uncertainty in the oscilloscope system (±2% for the oscilloscope mainframe and ±1.5% for the TCA75 adapter).*

9. Move the cable connection from the TG700 DVG7 to the HDVG7 SIGNAL 1 output. The waveform on the test oscilloscope will change, reflecting the 1.5 Gb/s serial rate. Select 100% color bars on the HDVG7.

10. Check the signal amplitude, using the 7 ns wide region without transitions. The amplitude should be very similar to that observed in step 7. Outside of the 7 ns region, check that the eye is open between transitions. See the following figure.

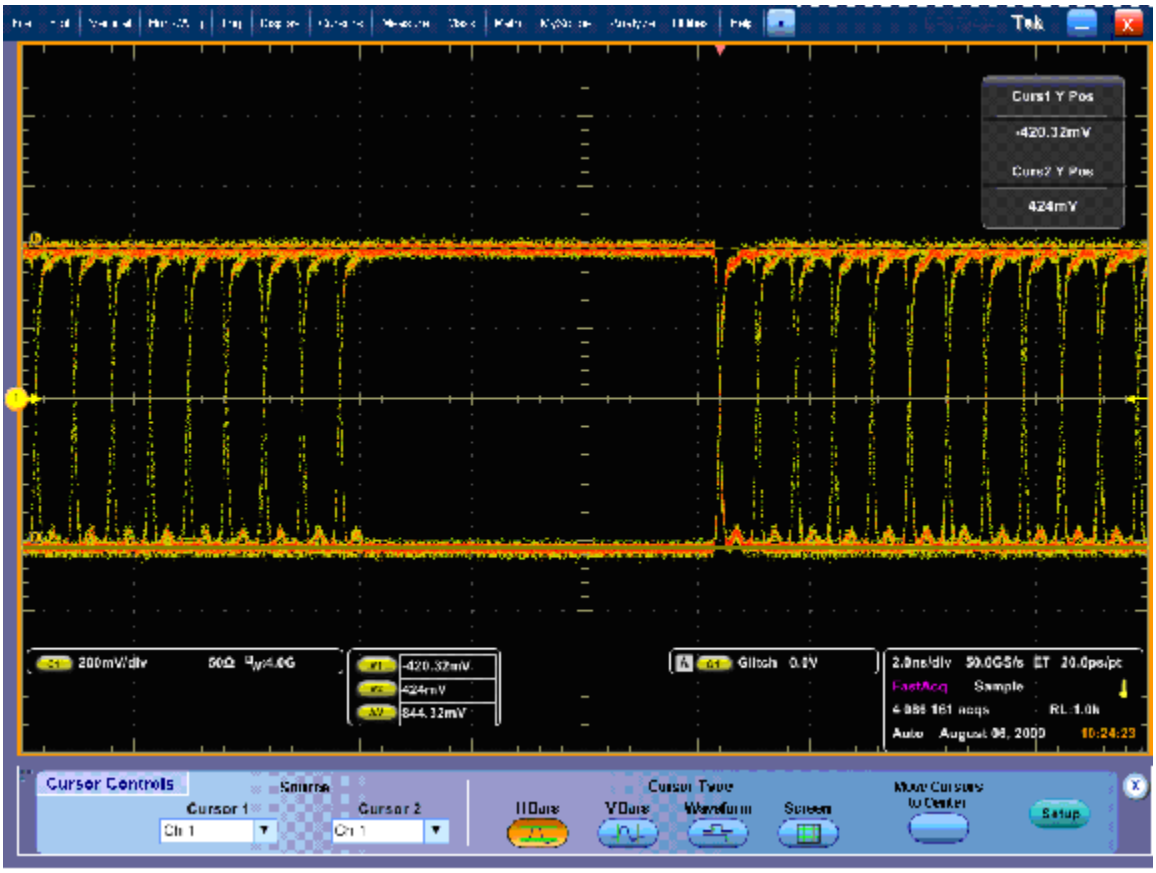

Figure 2: Serial Output at 1.5 Gb/s, using Glitch Trigger mode

11. Record the amplitude (ΔV) in the test record for 1.5 Gb/s. Amplitudes between 745 mV and 849 mV are acceptable.

12. If your instrument has Option 3G, perform steps 13 through 15.

13. Move the cable connection from the TG700 HDVG7 to the HD3G7 SIGNAL 1 output. The waveform on the test oscilloscope will change, reflecting the 3 Gb/s serial rate. Select 100% color bars on the HD3G7.

14. Check the signal amplitude, using the 7 ns wide region without transitions. The amplitude should be very similar to that observed in step 7. Outside of the 7 ns region, check that the eye is open between transitions. See the following figure.

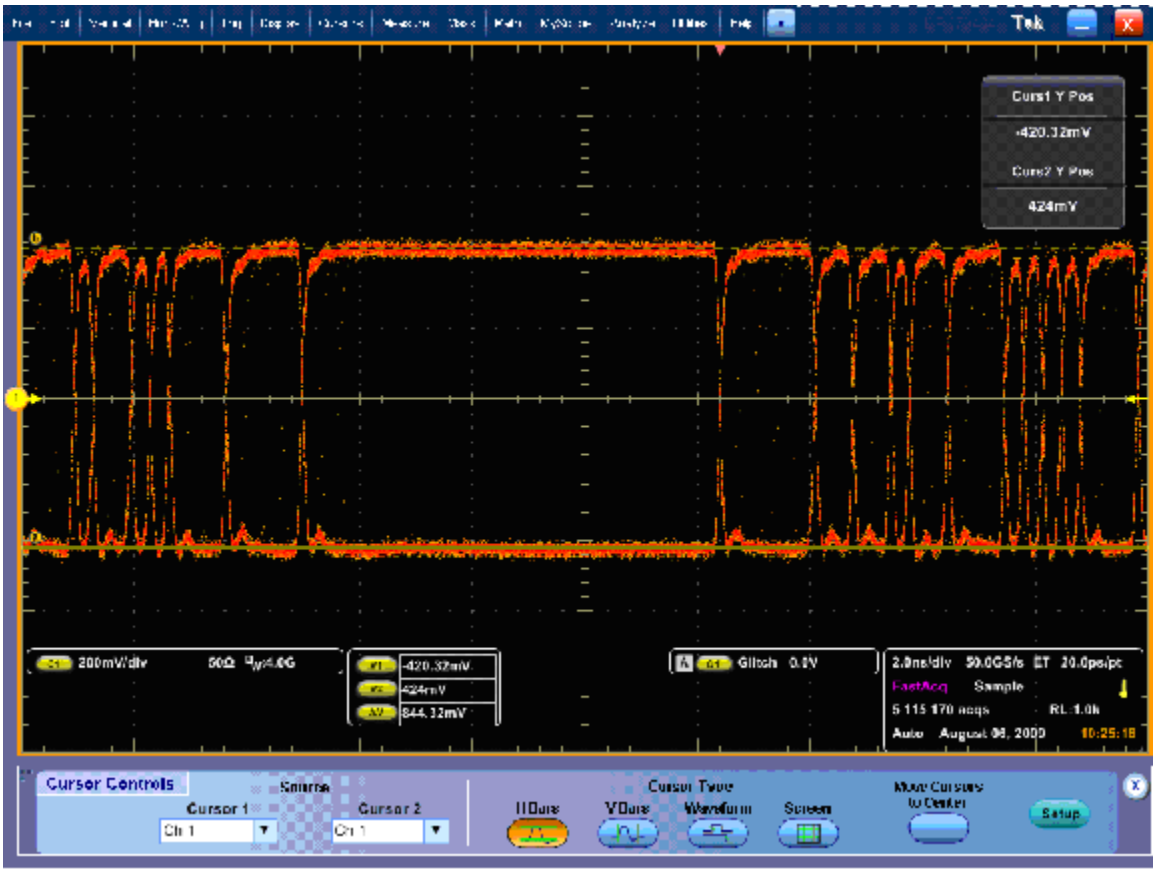

Figure 3: Serial Output at 3 Gb/s, using Glitch Trigger mode

15. Record the amplitude (ΔV) in the test record for 3 Gb/s. Amplitudes between 745 mV and 849 mV are acceptable.

Audio Performance Verification Procedures

Required Equipment

Table 46: Required test equipment (audio)

SDI serial digital video test generator with embedded audio	Generates the following signals:	Tektronix TG700 with the following modules:
	525/270 100% color bars with two or more groups of embedded audio.	DVG7 module for TG700
Analog/Digital audio generator/analyzer	35 kHz to 96 kHz sample rate range, jitter measurement per AES-3 (1997)	Rohde & Schwarz UPL06 Opt B22, B29
75 Ω coaxial cables (1 required)	General purpose digital video Male-to-male BNC connectors 3' long	Belden 8281
Audio test cable	1/4 inch phono to 2 XLR	Sound Professionals SP-XLRM-MINI-1 with adapter SP-PHONE-MINI-ST

The following tests verify that the Audio module for the WVR5200 Waveform Rasterizer meets the warranted characteristics listed in the Specifications chapter. Characteristics with typical specifications (not warranted) are also checked with pass/fail criteria.

Tests for Waveform Monitors Equipped with Audio Options

The tests in this section apply to instruments with Audio options installed. The tests will note when tests or their steps apply only to specific audio options; otherwise, they apply to all the audio options.

Headphone Output Level

This test measures the output level accuracy of the headphones.

Performance Requirement. This test verifies performance characteristics and is listed in the test record.

1. Set the instrument to the factory presets. (See page 32, *Restore the Factory Presets*.)
2. Press the **Display Select** (Thumbnail) button and select tile 4.
3. If the audio display is not visible, press the **Audio** button to activate the display.
4. Set the digital audio generator as follows:

Control or setting	Value
Output Level	–6 dB FS Sine
Frequency	100 Hz

5. Set the parameters in the ANALYZER panel as follows:

Control or setting	Value
INSTRUMENT	ANLG 22 kHz
Min Freq	10 Hz
Ref Imped	100000 Ω
Channel	1
Ch1 Coupl	AC
Ch1 Input	BAL
Ch1 Imped	200 kΩ
Ch1 Common	FLOAT
Ch1 Range	AUTO
START COND	AUTO
Delay	0.0000 s
INPUT DISP	OFF
FUNCTION	RMS & S/N
S/N Sequ	OFF
Meas Time	AUTO
Unit Ch1	DBu
Reference	VALUE: 1.0000 V
Sweep Mode	NORMAL
Notch (Gain)	OFF
Filter	OFF
Filter	OFF
Filter	OFF

6. Connect the DVG7 generator output to the instrument SDI 1A connector, using a 75 Ω cable.

7. Enable the Audio groups in the DVG7 module in the **Audio (Embedded)** > **Group [x]** menu.

8. Verify that the numbers 1,2 are visible under the headphone icon, in the audio tile.

9. Set the headphone output volume to maximum by turning the **Horz** (Volume) knob clockwise.

10. Connect the 1/4I male phono connector from the headphone test cable to the instrument headphone jack.
11. Connect the XLR corresponding to the ‘Left' channel to the analyzer balanced (BAL) analog input.
12. Check for 0.25 dBu ±1 dB RMS on the analog analyzer. Record the result in the test record.
13. Connect the XLR corresponding to the ‘Right' channel to the analyzer balanced (BAL) analog input.
14. Check for 0.25 dBu ±1 dB RMS on the analog analyzer. Record the result in the test record.
15. Set the DVG7 generator as follows:

Control or setting	Value
Output Level	–6 dB FS Audio Tone
Frequency	1 kHz

16. Repeat steps 9 through 12.
17. Set the DVG7 generator as follows:

Control or setting	Value
Output Level	–6 dB FS Audio Tone
Frequency	20 kHz

18. Repeat steps 9 through 12.

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